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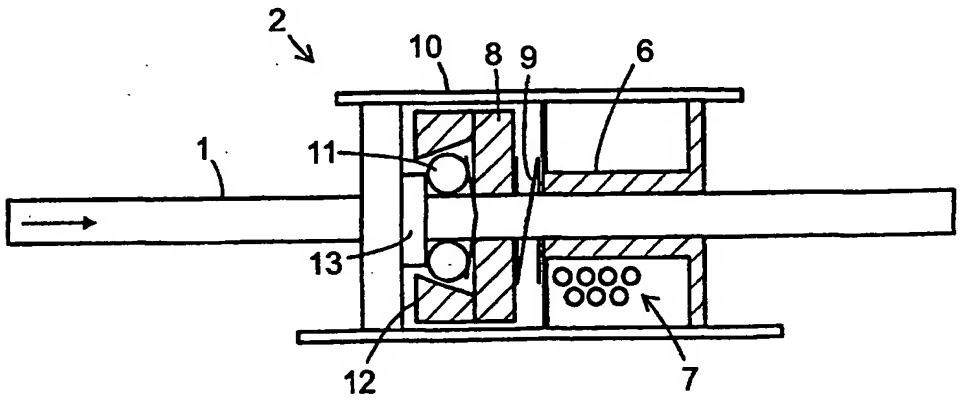
(54) Title: SHAFT CONTROLLING DEVICE



(57) Abstract: The invention concerns a system for the axial operation of a shaft (1) to one or more positions. The operation is achieved by one or more functional blocks that can be combined with each other and that can drive the shaft in either direction with variable steps, with variable speed and with variable force; or that are arranged to disengage, brake or lock the shaft (1). The functional blocks comprise a magnetic core (6) with a winding (7) together with a moving magnetic part (8) arranged on the shaft (1) and means (11.13) to achieve locking between the shaft and the locking means, for movement of the shaft together with the moving part (8) when the latter is drawn towards the core (6) on magnetisation. One special use of the invention is in association with gear-boxes of vehicles, in which combinations of units give a simple solution with great rapidity and force.

WO 01/33583 A1

Shaft-controlling device

DESCRIPTION

Technical Area

The present invention concerns a system for the axial operation of a shaft to one or more positions.

One special use of the invention is in association with gear-boxes of vehicles. The operation according to the invention is achieved both by using simple functions such as driving and blocking of certain positions under certain conditions, and by using more complex functions such as changing between various gearing positions, and similar functions.

The Prior Art

According to the prior art, electromagnets, servo-controlled motors, pneumatic devices or hydraulic devices, for example, are used in order to move a shaft parallel to the direction of the shaft. In most cases, the known solutions are complicated or have weaknesses. For example, the known devices often have the disadvantage that they cannot execute the displacement with sufficient speed, with a sufficiently large drawing force, with sufficient torsional force or with the desired accuracy.

The system according to the invention has been developed by analysing the possible electrical methods of operation in association with the gear-boxes of vehicles, but the system can, of course, be used for many other applications in which a shaft is to be operated. The system according to the invention has few components that are combined in various combinations to provide operating devices with the desired characteristics. One particular advantage of the system is that it is variable and can be controlled, using, for example, a computer, such that an extremely rapid operation, that is, release, can be obtained.

Brief Description of the Invention

The invention concerns a system that is intended to relieve the disadvantages that are associated with known devices for operating a shaft to one or more positions along the direction of the shaft. Thus, the system according to the invention is built up of one or more functional blocks having an electromagnetic effect and that can be combined with each other. The functional blocks each have variable properties and each is controlled by a power supply.

Each functional block influences the shaft according to its properties, that is, each functional block is arranged to operate the shaft in either direction by variable steps, variable speeds and with variable force; and to disengage, brake and/or lock the shaft in a second direction.

Thus, according to the invention, the system comprises functional blocks that constitute a driving unit to drive the shaft in one direction and to brake, lock or disengage the shaft in the other direction. The system also comprises functional blocks that constitute a reversing lock, that is, functional blocks that are released when, for example, a spring on the shaft has been `loaded', that is, compressed or extended by a driving unit, together with combinations of similar functional blocks.

A driving unit or a reversing lock for a shaft comprises a magnetic core with a coil together with a moving magnetic part that can assume an extended position and a non-extended position. Alternatively, either of the magnetic parts can be constituted by a permanent magnet. Furthermore, a locking device is included in order to lock/disengage the shaft at the moving magnetic part.

According to one embodiment, the system concerns the combination of at least one driving unit, the moving magnetic part of which is moved between two positions when power is applied, thereby displacing a shaft in one direction. The shaft in turn carries out a task, which may, for example, be the compression of a spring arranged on the shaft. The system furthermore comprises a reversing lock that holds the spring. The compression of the spring is stopped at the desired position on the shaft *via* a position-sensitive detector and the spring is released by the magnetisation of the reversing lock and the release of its locking function. The process can be advantageously controlled by a computer.

According to another embodiment, two units are arranged, each with at least one driving unit and one reversing lock, whereby the driving units each. Load a spring that is released by the reversing lock at the desired position on the relevant shaft. The units are arranged on opposite sides of a operating arm in order to drive the operating arm in opposite directions with slow loading by the driving unit and the subsequent rapid release of the reversing lock. This system also can be advantageously controlled by a computer.

Other characteristics of the invention are specified in the subsequent claims.

Description of the Drawings

The invention will now be described in more detail with the aid of embodiments that are made evident by the followings drawings.

Figure 1 shows schematically the fundamental elements of the system according to the invention;

Figure 2 A, B show examples of functional blocks and their combination according to the invention;

Figure 3 shows an embodiment of a driving unit according to the invention with the shaft disengaged;

Figure 4 shows an alternative embodiment for locking of the shaft;

Figure 5 A, B show two alternative methods of controlling a driving unit;

Figure 6 shows an embodiment of a reversing lock according to the invention;

Figure 7 shows a system according to the invention comprising priming and release of a spring;

Figure 8 shows an application according to the invention comprising two systems according to that shown in Figure 7.

Description of Embodiments

Figure 1 shows electromechanical basic elements that are part of the system according to the invention. A shaft 1 is generally a common element for the construction of a complete system. An electrically controlled driving unit 2 is arranged to drive the shaft in either direction. The driving unit 2 can be achieved in various ways and several driving units can be combined in order to obtain the desired driving force. For example, a driving unit 2 that drives the shaft 1 with a large force in one direction can be combined with one or more driving units 2 that drive the shaft with less force in the other direction. A locking unit 3 can also be attached to the shaft 1, which locking unit is electrically controlled and can be used alone or in combination with, for example, driving unit 2. A computer or other control device (not shown in the diagram) is arranged to control the units shown. In addition to the units shown, a position-sensitive detector and other sensors and elements can be included in the system.

Figure 2 shows examples of functional blocks with different properties that are attached to a shaft and achieve displacement of the shaft in different ways and with different characteristics.

Figure 2 A shows a driving unit 2 that can drive the shaft 1 in the direction of the arrow. Two combined driving units 2 are shown in Figure 2 B, which drive the shaft each in one direction. Displacement occurs by the driving units 2 feeding the shaft forwards in a stepwise manner. This forward feed can be achieved with fixed or with variable steps, depending on the desired result. An example is shown in Figure 2 B in which a computer 4 controls the two driving units 2 in a servo-coupling 5 with feedback for positional determination.

Further units can be included in the system according to the invention. A more detailed description of some functions and combinations is given below.

Figure 3 shows an example of the electromagnetic construction of a driving unit 2. A magnetic circuit is formed by a core 6 that is magnetised by a winding 7 and which in turn influences a moving magnetic part 8 such that the moving part is drawn towards the core 6, in the direction of the arrow. The moving magnetic part is spring-loaded in a direction away from the core 6 by means of a spring 9. Magnetic closure is achieved through a cover 10.

If the winding 7 is fed with pulsed current, the moving magnetic part 8 will be alternately drawn towards the core 6 by the force of magnetism and repulsed backwards by the force of the spring.

When the moving magnetic part 8 is drawn towards the core 6, balls or rollers 11 exist arranged to achieve locking between a locking part 12, which in this case is a cone-shaped part, of the moving magnetic part 8 and the shaft 1 and a stop 13, attached to the cover 10, which stops the balls or rollers 11. When locking has been achieved, the shaft 1 is displaced together with the moving magnetic part 8 when this is drawn towards the magnetised core 6. Since the moving part 8 is spring-loaded and the balls or rollers 11 are stopped against the stopper 13, the shaft 1 will normally be disengaged when the moving magnetic part 8 is not drawn towards the core 6, that is, when the core is not magnetised by current, as is shown in Figure 3.

The magnetic circuit can naturally be designed in another way. For example, permanent magnets with or without a coil can be used and the moving magnetic part can consist of a permanent magnet.

The spring can also be replaced by a "magnetic force" and the balls or rollers can, for example, be composed of wedge-shaped elements or similar, with a locking part adapted to such elements.

The driving unit 2 can be combined with a normal friction brake that brakes the motion of the shaft when the shaft is disengaged from the locking part.

Instead of the locking using balls or rollers 11 and a cone-shaped locking part 12 that is shown in Figure 3, other alternative locking arrangements can be arranged, see Figure 4.

Figure 4 shows an alternative locking of the shaft 1 with respect to the moving magnetic part 8 by means of a flap 14 that is equipped with a hole the diameter of which is slightly greater than the diameter of the shaft 1. The flap 14 is pivoted about a point A and is pressed against the shaft by a spring force B. A locking or blocking effect is achieved in this way. If the pivotal point A is subjected to a force in the direction of the arrow C, the shaft 1 will follow. The flap 14 has a resting position that does not place a load on the spring force B such that disengagement is obtained in a similar manner as with the embodiment using balls according to Figure 3.

By combining a magnetic force according to Figure 3 with a locking according to Figure 4, a very simple and economic solution is obtained.

Figure 5 A shows an example of the control electronics for the driving unit. Figure 5 A shows how a simple pulse generator 15 with fixed or variable frequency drives the magnetic circuit directly, without feedback. This gives a very simple and cost-effective solution for simple applications.

Figure 5 B shows how feedback of the position of the moving magnetic part, as detected by a sensor 16, achieves a "mechanical oscillator". The moving magnetic part 8 is caused to move between its end positions, according to the double arrow shown, with the greatest speed possible. It is possible in this alternative to control how far the moving part is to "be allowed back" before it is again drawn towards the core. By controlling the air-gap in the magnetic circuit in this way, an "electronic gearbox" can be achieved. It is namely the case that if the air-gap in the magnetic circuit is small, the drawing power is large, and *vice versa*.

Figure 6 shows the mechanical construction of a locking unit. The locking unit functions as an electrically controlled reversing lock for the shaft 1. It replaces the frictional coupling that has been mentioned above. It functions as follows:

If we assume that the shaft 1 is subjected to a spring pressure in the direction of the arrow A, balls or other locking elements 17 will lock the shaft 1 through a locking part 18 that is firmly attached. A weak spring 19 ensures that the balls are kept in place. In this condition, the locking unit constitutes a reversing lock for the shaft 1, which thus can be driven in the direction of the arrow B even if the arrow A represents a spring force. The moving magnetic part 20 with a tube-shaped extension 21, which extension constitutes a tube that is located between the shaft 1 and the tube-shaped magnetic core 22 and stretches from the moving magnetic part 20 on the one side of the core to the balls 17 that are located on the other side of the core, is arranged to influence the balls 17, when the moving magnetic part is drawn towards the core 22 on being magnetised. In this way, the balls 17 release their contact with the locking part 18, the locking function ceases and the shaft 1 is free to move. The arrow A represents a spring that has been compressed by the shaft 1, that is, the shaft 1 has loaded the spring by moving in the direction of the arrow B in the example shown. The spring is released by supplying power to the reversing lock such that the tube-shaped extension part 21 influences the contact of the balls 17 against the locking part 18.

Naturally, the magnetic circuit and the springs can be arranged such that the relationship between them is the opposite; power is required for the locking function to be present, and the locking unit is released by interruption of the current.

Naturally, the locking unit can be designed with flap-locking according to Figure 4, instead of balls or rollers or other locking elements.

Figure 7 shows an application in association with gear-boxes in which there is a requirement for rapid movement, which movements are monitored by position detection. In the example shown, there exists a gear-driver, that is, the shaft 1, that can take four or more alternative positions 1-4. There is generally a requirement for relatively large forces. This can, of course, be achieved in the conventional manner using servo-motors and all of their traditional problems of acceleration times and overrun, giving in general complicated and expensive solutions. By combining units from the system according to the invention, it is possible to achieve a simple solution that is very rapid.

A driving unit 23, such as, for example, that according to Figure 3, loads a spring 24 that is held by a locking unit 25, as shown in Figure 6. The position of the shaft 1 is monitored by a position-sensitive detector 26, such as a potentiometer, which can stop the shaft in the desired position. The positions 1-4 have been specified in the figure, but naturally

other continuous positions can also be obtained. It is also possible for a shock-absorbing device 27 to be included in the system in order to reduce the speed of the motions.

The combination that is shown in Figure 7 gives a system in which the motion of the shaft is very rapid in the direction in which the spring is released, that is, to the left in Figure 7, while more time is required in order to prime the spring, that is, to move the shaft to the right in Figure 7.

Figure 8 shows an application of the system shown in Figure 7. Figure 8 thus shows two devices 28, 29 that work in different directions, which devices can be designed according to Figure 7. A very rapid adjustment of, for example, a gear-changer can be achieved with this construction. The units 28, 29 normally have a "home position" with the spring loaded on the relevant shafts 1. When the computer 30 gives a signal for change to a position detector 31 for change of the position of a operation arm 32, for example from 3 to 1, the locking unit 29 at the right of the figure will "release" its spring to the desired position and carry with it the operating arm 32 in order to immediately then return to its "home position" and in this way also load the spring.

It is clear to one skilled in the arts that the embodiments described here are only to be viewed as examples, and the system according to the invention can be varied in many different ways within the field of the invention.

CLAIMS

1. System for the axial operation of a shaft (1), for example a gear-changing shaft in a gear-box, which system comprises:
-at least one electromagnetic driving unit (23) with a means of locking the shaft for simultaneous movement with the driving unit with variable steps, variable speed and variable force in one direction, and to disengage the shaft from the driving unit in the second direction, together with
- at least one electromagnetic reversing locking unit (25) with a locking means in order to lock the shaft in the opposite direction,
c h a r a c t e r i s e d in that the shaft (1) is arranged to be driven in the said first direction to a certain position by means of a driving unit (23), whereby the shaft (1) is arranged to compress (load) a spring (A, 24), which spring is held in position by a reversing locking unit (25), after which the spring (A, 24) is released by magnetising the reversing locking unit (25) whereby the locking means is released and the shaft rapidly returns to the desired position.

2. System according to claim 1, c h a r a c t e r i s e d in that the means of the driving unit for locking the shaft (1) comprises a locking part with a flap (14) that is arranged to be pressed against the shaft such that the shaft accompanies the flap when this is moved with a certain force, and is disengaged if the movement force ceases. (Figure 4).

3. System according to claim 1, c h a r a c t e r i s e d in that the means at the driving unit for locking the shaft (1) comprises rollers or wedge-shaped elements that are gripped tightly between a locking part (12) and the shaft. (Figure 3).

4. System according to claim 1, c h a r a c t e r i s e d in that the means at the driving unit for locking the shaft comprises a friction brake connected between the driving device and the shaft.

5. System according to any of the preceding claims, c h a r a c t e r i s e d in that the power to the electromagnetic units is controlled by a computer (4).

6. System according to any of the preceding claims, c h a r a c t e r i s e d in that the position of the shaft (1) is detected by a sensor (16) the result of which is fed back *via* a computer and controls the power supply of the control-system. (Figure 5 B).

7. System according to any of the preceding claims, c h a r a c t e r i s e d in that two units (28, 29) each of them having at least one driving unit and one reversing lock, whereby each driving unit loads a spring that is released at the desired position of the shaft, which units are arranged on opposite sides of a operating arm (32) in order to drive the operating arm in opposite directions with a slow loading and subsequent rapid release. (Figure 8).

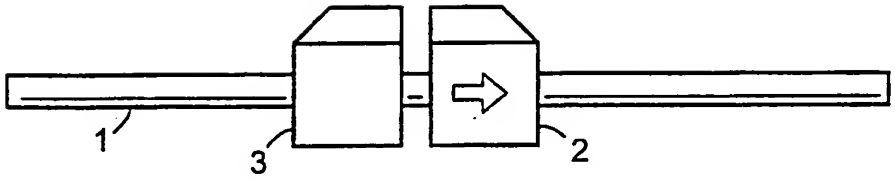


FIG. 1

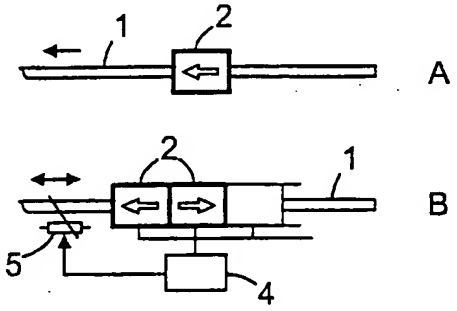


FIG. 2

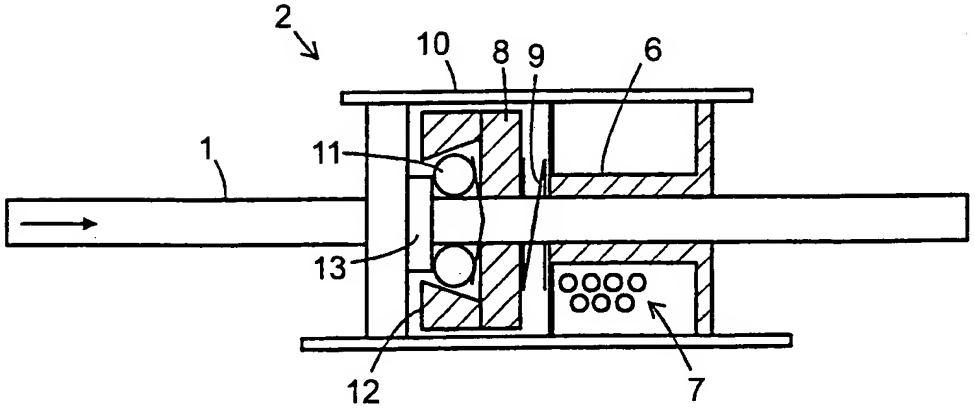


FIG. 3

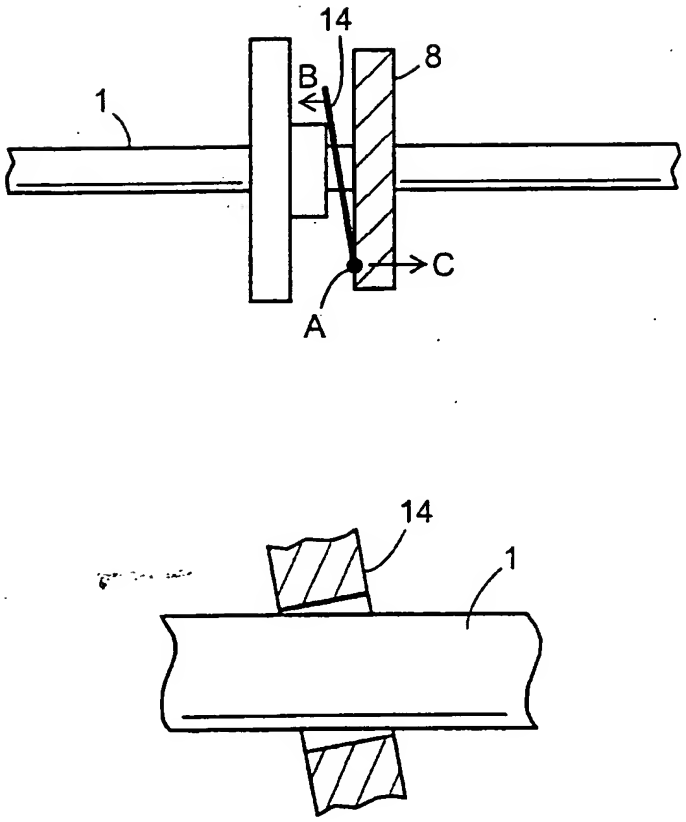


FIG. 4

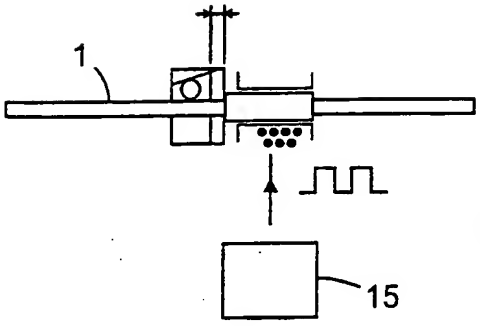


FIG. 5A

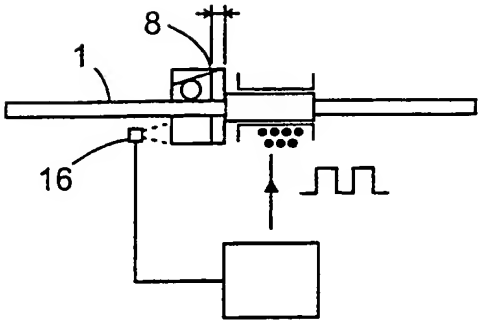


FIG. 5B

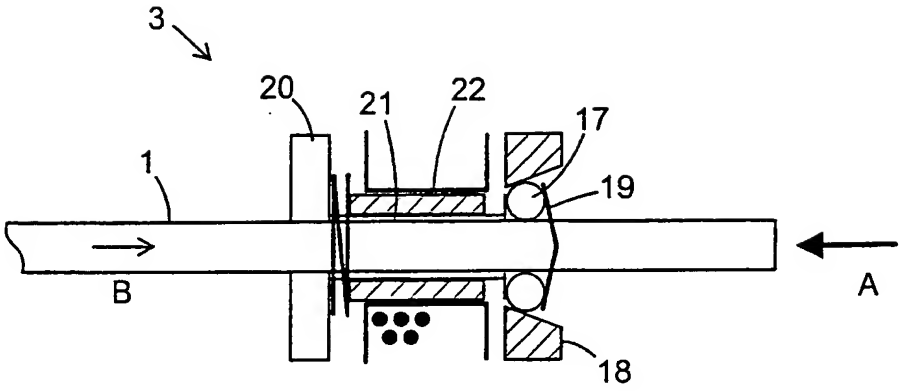


FIG. 6

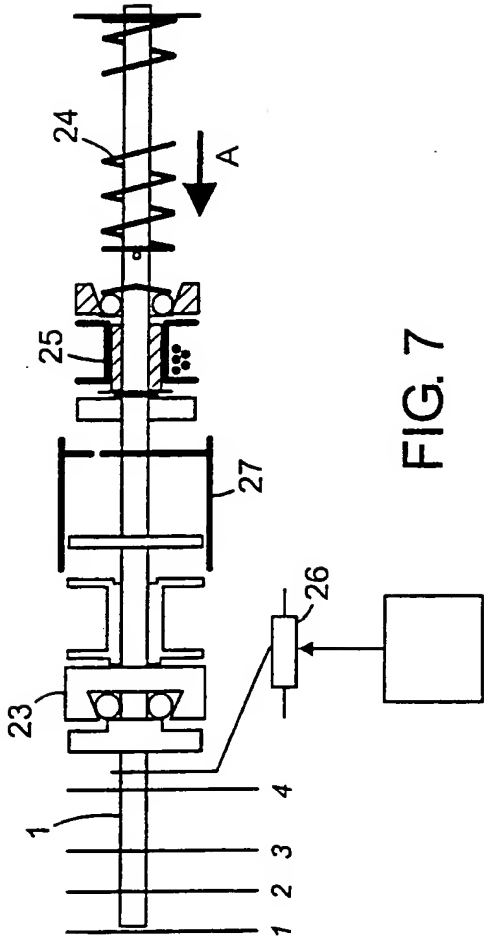


FIG. 7

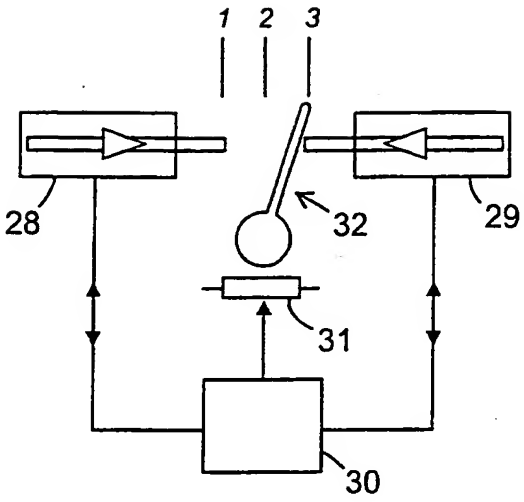


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/02119

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01F 7/16, H02K 7/06, F16H 49/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H01F, H02K, F16H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 19749628 A1 (INNOTEC GES.M.B.H.), 12 May 1999 (12.05.99) --	1-7
A	EP 0157631 A2 (PARKER-HANNIFIN CORPORATION), 9 October 1985 (09.10.85) --	1-7
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A	DE 3233759 A1 (MARUHA DENKI K.K.), 14 April 1983 (14.04.83) -- --------	1-7

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SE 00/02119

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